

REMARKS/ARGUMENT

New claims 51-52 have been added by this submission. Accordingly, claims 10-19, 21, 22 and 25-52 are pending in the present application.

Applicant wishes to thank the Examiner for the courtesy extended to Applicant's attorney during telephone interviews conducted on January 4, 2002, and January 7, 2002.

As discussed during the telephone interviews, neither the JP(I) reference, Sliwa nor Sherry, either alone or combined, teach or suggest the device joining method as called for by independent claims 10 and 27. In particular, none of the cited references, or their combination, teach or suggest a method of joining a substrate electrode to a device electrode by placing the device in the liquid such that the device electrode and the substrate electrode are *out of alignment* with each other and then melting a solder bump between the device and substrate electrodes so as to cause the device and substrate electrodes to align. Accordingly, it is respectfully submitted that independent claims 10 and 27 patentably distinguish over the art of record, and allowance of these claims is respectfully requested.

Claims 11-19, 21-22 and 25-26 depend either directly or indirectly from claim 10 and include all of the limitations found therein. Claims 28-50 depend either directly or indirectly from claim 27 and include all of the limitations found therein. Each of these dependent claims include additional limitations which, in combination with the limitations of the claims from which they depend are neither disclosed nor suggested in the art of record. Accordingly, claims 11-19, 21-22, 25-26 and 28-50 are likewise patentable.

New claims 51 and 52 have been added to more fully cover the scope of the present invention. Consideration and allowance of these claims is respectfully requested.

The prior art made of record and not relied upon has been carefully reviewed. It is believed that these references, either alone or combined with any other references of record, do not render the pending claims unpatentable.

In view of the foregoing, favorable consideration of new claims 51-52, and allowance of the application with claims 10-19, 21, 22 and 25-52 is respectfully and earnestly solicited.

I hereby certify that this correspondence is being sent to the U.S. Patent and Trademark Office via facsimile transmission to the attention of Examiner Elve at No. (703) 872-9418, on January 7, 2002

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Name of applicant, assignee or
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Signature

January 7, 2002

Date of Signature

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Respectfully submitted,

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APPENDIX A
"CLEAN" VERSION OF EACH PARAGRAPH/SECTION/CLAIM
37 C.F.R. § 1.121(b)(ii) AND (c)(i)

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CLAIMS (with indication of amended or new):

51. (New) A method of joining a plurality of substrate electrodes formed on a substrate and a plurality of respective device electrodes formed on a device to each other by solder to mount said device on said substrate, the method comprising:

attaching a respective solder piece to each of said plurality of substrate electrodes;
melting each said respective solder piece while each said respective solder piece is at least partially submerged in a liquid to form respective solder bumps having an adhered surface and an opposite surface;
positioning said plurality of respective device electrodes so as to contact said opposite surface of said respective solder bumps such that the centers of said plurality of respective device electrodes are not aligned with the respective centers of said plurality of substrate electrodes while said device is at least partially submerged in said liquid;

aligning the centers of said plurality of respective device electrodes with the respective centers of said plurality of substrate electrodes by surface tension of said respective solder bumps when said respective solder bumps are melted and while said device is at least partially submerged in said liquid and at least partially supported by a buoyant force thereby joining said plurality of substrate electrodes and said plurality of respective device electrodes to each other; and
solidifying said respective solder bumps.

52. (New) A method of joining a device to a substrate, the substrate having a plurality of solder pieces electrically coupled to a plurality of substrate electrodes, the method comprising:

placing the substrate in a liquid;

melting the plurality of solder pieces to form a plurality of solder bumps while the substrate is in the

5 liquid;

placing a device having a plurality of respective device electrodes on the plurality of solder bumps while the device is in the liquid such that the plurality of respective device electrodes are out of alignment with a respective substrate electrode of the plurality of substrate electrodes; and

melting the plurality of solder bumps so as to cause the plurality of respective device electrodes to align with the plurality of respective substrate electrodes while the device and the substrate are in the liquid.



APPENDIX C

COMPLETE CLEAN SET OF PENDING CLAIMS
37 C.F.R. § 1.121(c)(iii)

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CLAIMS:

10. A method of joining a substrate electrode formed on a substrate and a device electrode formed on a device to each other by solder to mount said device on said substrate, the method comprising:

attaching a solder piece to said substrate electrode;

melting said solder piece while said solder piece is at least partially submerged in a liquid to form a solder bump having an adhered surface and an opposite surface;

positioning said device electrode so as to contact said opposite surface of said solder bump such that the center of said device electrode is not aligned with the center of said substrate electrode while said device is at least partially submerged in said liquid;

aligning the center of said device electrode with the center of said substrate electrode by surface tension of said solder bump when said solder bump is melted and while said device is at least partially submerged in said liquid and at least partially supported by a buoyant force thereby joining said device electrode and said substrate electrode to each other; and

solidifying said solder bump.

11. The method as claimed in claim 10, wherein as said solder piece is melted to form said solder bump, a vibration is applied to said solder piece while said solder piece is at least partially submerged in said liquid.

12. The method as claimed in claim 10, wherein when said solder bump is melted while said solder bump is at least partially submerged in said liquid to join said device electrode and said substrate electrode to each other, a vibration is applied to said solder bump while said device is at least partially submerged in said liquid.

13. The method as claimed in claim 10, wherein said liquid is inactive to said solder, said device and said substrate.

14. The method as claimed in claim 10, wherein said device is an optical device.
15. The method as claimed in claim 10, wherein said device is a semiconductor device.
16. The method as claimed in claim 10, wherein said substrate is a semiconductor substrate.
17. The method as claimed in claim 10, wherein said substrate is a substrate for mounting an electric element.
18. The method as claimed in claim 10, wherein said substrate is a ceramic substrate.
19. The method as claimed in claim 10, wherein said substrate is a printed circuit board.
21. The method as claimed in claim 11, wherein said vibration is applied ultrasonically.
22. The method as claimed in claim 12, wherein said vibration is applied ultrasonically.
25. The method as claimed in claim 22, wherein said vibration is applied ultrasonically through said liquid to said solder bump disposed in said liquid.
26. The method as claimed in claim 25, wherein an oxide film on the surface of said solder bump is broken to enhance the surface tension when said solder bump is melted.
27. A method of joining a device to a substrate having a solder piece electrically coupled to an electrode of the substrate, the method comprising:
- placing the substrate in a liquid;
 - melting the solder piece to form a solder bump while the substrate is in the liquid;
 - placing a device having a device electrode on the solder bump while the device is in the liquid such that the device electrode is out of alignment with the substrate electrode; and

melting the solder bump so as to cause the device electrode to align with the substrate electrode while the device and the substrate are in the liquid.

28. The method as claimed in claim 27, wherein a center of the device electrode is out of alignment with a center of the substrate electrode during the placing of the device on the solder bump.

29. The method as claimed in claim 28, wherein the device is buoyantly supported by the liquid during the melting of the solder bump.

30. The method as claimed in claim 29, wherein the center of the device electrode and the center of the substrate electrode are aligned with each other during the melting of the solder bump.

31. The method as claimed in claim 27, further comprising:
applying a vibration to the solder piece during the melting thereof.

32. The method as claimed in claim 31, wherein the vibration is an ultrasonic vibration.

33. The method as claimed in claim 31, wherein the vibration is applied to the solder piece through the liquid.

34. The method as claimed in claim 31, wherein the vibration is applied to the solder piece in an amount sufficient to break an oxide film formed on the surface of the solder piece.

35. The method as claimed in claim 31, further comprising:
applying a vibration to the solder bump during the melting thereof.

36. The method as claimed in claim 35, wherein the vibration is an ultrasonic vibration.

37. The method as claimed in claim 35, wherein the vibration is applied to the solder bump through the liquid.

38. The method as claimed in claim 35, wherein the vibration is applied to the solder bump in an amount sufficient to break an oxide film formed on the surface of the solder bump.

39. The method as claimed in claim 35, wherein the vibration is applied to the solder bump in an amount sufficient to increase a surface tension of the solder bump.

40. The method as claimed in claim 39, wherein the amount of vibration applied to the solder bump is sufficient to cause the surface tension of the solder bump to reach a maximum.

41. The method as claimed in claim 35, wherein the vibration is applied to the solder bump in an amount sufficient to deform the solder bump.

42. The method as claimed in claim 41, wherein the deformation of the solder bump causes the alignment of the device electrode with the substrate electrode.

43. The method as claimed in claim 27, further comprising:
solidifying the solder bump to fix the device to the substrate.

44. The method as claimed in claim 27, wherein the liquid is inactive to the device and the substrate.

45. The method as claimed in claim 27, wherein the device is an optical device.

46. The method as claimed in claim 27, wherein the device is a semiconductor device.

47. The method as claimed in claim 27, wherein the substrate is a semiconductor substrate.

48. The method as claimed in claim 27, wherein the substrate is a substrate for mounting an electric element.

49. The method as claimed in claim 27, wherein the substrate is a ceramic substrate.

50. The method as claimed in claim 27, wherein the substrate is a printed circuit board.

51. A method of joining a plurality of substrate electrodes formed on a substrate and a plurality of respective device electrodes formed on a device to each other by solder to mount said device on said substrate, the method comprising:

attaching a respective solder piece to each of said plurality of substrate electrodes;

melting each said respective solder piece while each said respective solder piece is at least partially submerged in a liquid to form respective solder bumps having an adhered surface and an opposite surface;

positioning said plurality of respective device electrodes so as to contact said opposite surface of said respective solder bumps such that the centers of said plurality of respective device electrodes are not aligned with the respective centers of said plurality of substrate electrodes while said device is at least partially submerged in said liquid;

aligning the centers of said plurality of respective device electrodes with the respective centers of said plurality of substrate electrodes by surface tension of said respective solder bumps when said respective solder bumps are melted and while said device is at least partially submerged in said liquid and at least partially supported by a buoyant force thereby joining said plurality of substrate electrodes and said plurality of respective device electrodes to each other; and

solidifying said respective solder bumps.

52. A method of joining a device to a substrate, the substrate having a plurality of solder pieces electrically coupled to a plurality of substrate electrodes, the method comprising:

placing the substrate in a liquid;

melting the plurality of solder pieces to form a plurality of solder bumps while the substrate is in the liquid;

placing a device having a plurality of respective device electrodes on the plurality of solder bumps while the device is in the liquid such that the plurality of respective device electrodes are out of alignment with a respective substrate electrode of the plurality of substrate electrodes; and

melting the plurality of solder bumps so as to cause the plurality of respective device electrodes to align with the plurality of respective substrate electrodes while the device and the substrate are in the liquid.